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Diurnal patterns of ozone and precursors in the South Coast, 1994 and 1998

Jeff Austin
Planning and Technical Support Division
California Air Resources Board

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As part of our ongoing analysis of weekday-weekend differences in the behavior of ozone concentrations, we examined diurnal profiles for ozone, oxides of nitrogen (NO_x) and carbon monoxide (CO) for all sites reporting data in the South Coast Air Basin, for May-October, 1994 and 1998. This document is a brief summary of our findings. The time period was chosen based on the recent ARB Analysis (Austin and Tran, 1999), which found a weekend effect at many sites throughout California, with Saturday typically experiencing the highest concentrations in 1992-1994, and Sunday in 1996-98. The South Coast was chosen for its high ozone concentrations and large number of monitoring sites in a variety of settings. Data were available for 29 ozone monitors, 22 NO_x monitors, and 20 CO monitors. Data for non-methane hydrocarbons (NMHC) were only available for five sites, for 1994 only, and the coarse resolution of the data blurred day-to-day differences. Therefore, we do not present results for hydrocarbon data.

To construct the diurnal profiles, we grouped the data by day of week and averaged over each hour of the day. Therefore, the level of a diurnal profile for Saturday, for 5 AM, is the mean of all 5 AM PST concentrations over all Saturdays for a given site and year, from May through October. We also plotted and examined individual daily profiles for outliers, to ensure that the average diurnal profiles were not unduly influenced by anomalous observations. Separate profiles were constructed for each site and each of the two years under study. Weekdays, Monday-Friday, generally behaved similarly, with some exceptions noted below. Therefore, weekdays were averaged together to obtain a single profile. Each profile is constructed from roughly 26 days of data, for Saturday and Sunday, and 130 days, for the weekday mean.

The descriptions presented below represent an attempt to characterize overall patterns. To be included in the description, a pattern had to be present at several sites. A given site, in a given year, may lack some of the characteristics described.

Ozone

- In 1998,
  - The Sunday peak is highest, followed by Saturday, then the average weekday peak (Figures 2-4).
  - At urban sites, Sunday appears to diverge from other days early in the morning. By 5 AM PST, the Sunday mean concentration is appreciably higher than other days (Figures 2-5).
  - In most of the basin, the Saturday and Sunday peaks occur at roughly the same time of day as the mean weekday peak, or slightly earlier (Figures 1-4). In the eastern part of the basin, in the San Bernardino and Riverside areas, Saturday and Sunday tend to peak 1-2 hours later (Figure 4).
  - Profiles for long distance transport sites (e.g. Lake Gregory, Banning, Hemet) have a characteristic shape, with a low peak or shoulder around 1 PM PST, and a higher peak occurring late in the afternoon, evidently due to transport. Weekday-weekend differences are generally less pronounced than at urban sites (Figure 6).

- Differences between 1994 and 1998
  - Peak concentrations are almost uniformly lower in 1998. At some sites, the peak occurs 1-2 hours later in the day in 1998.
  - In 1994, Saturday and Sunday peaks tend to occur at roughly the same time as the mean weekday peak. The late weekend peak observed in the 1998 San Bernardino and Riverside profiles is not apparent in 1994.
  - In 1998, Sunday almost uniformly has the highest peak (Figure 2). In 1994, Saturday is typically the highest, although Sunday is highest in a few cases (Figure 1).

Oxides of nitrogen

- Profiles are very similar in shape from site to site and year to year. They show an AM peak, afternoon low, and evening buildup (Figures 7, 8).
- The magnitude of the concentrations varies from site to site. Concentrations in 1998 are almost uniformly lower than in 1994.
- Sunday concentrations are uniformly lower than other days except at midnight to 4 AM, when they are comparable with weekday concentrations Sunday (Figure 7).
- Saturday AM concentrations are higher than Sunday and lower than the mean weekday in almost all cases. Saturday afternoon concentrations are comparable to or slightly lower than weekday concentrations. Saturday evening concentrations tend to be lower than Friday concentrations and roughly equal to or higher than the mean weekday evening concentrations.
- In 1998, many sites show elevated NO_x concentrations on Friday evening / Saturday morning, and some show elevated concentrations on Saturday evening / Sunday

morning. This tends to confirm the widespread belief that driving activity is higher on weekend evenings (Figure 8).

- Since there is generally more atmospheric dispersion in the afternoon, the same rate of emission tends to result in lower concentrations in the afternoon than in the morning. Therefore, as an indicator of differences in emission levels on different days, a small difference between profiles in the afternoon may be as significant as a large difference in the morning.

Carbon monoxide

- The shapes of the carbon monoxide profiles are very similar to the shape of the NOx profiles, showing the same AM peak, afternoon low, and evening buildup (Figures 9, 10).
- Like NOx, the CO profiles are very similar from site to site and year to year.
- 1998 concentrations are generally lower than 1994 concentrations.
- In the morning and afternoon, weekday concentrations are highest, followed by Saturday, then Sunday. The only exception is Lynwood in 1998, where Saturday afternoon concentrations are slightly higher than other days (Figure 11)
- The Friday and Saturday evening buildup observed for NOx is present at some sites, although not as prevalent as for NOx (Figure 9).
- Weekend midnight to 4 AM concentrations are often relatively high (Figures 9, 10).
- The comment regarding the effect of atmospheric dispersion on NO_x concentrations also applies to CO (see above).

Possible areas for future study

- Extend analysis to other years and other geographic areas.
- Construct diurnal profiles of continuous speciated HC concentrations (3 hour averages measured by automated gas chromatography).
- Apply multivariate statistical techniques to test specific statistical hypotheses suggested by plots.
- Partition data into high and low ozone days and compare.
- Investigate the relationship between diurnal profiles and traffic flows and vehicle activity in the vicinity of monitors.
- Investigate sites in relation to local topography and emissions sources to see if patterns exist among sites affected by similar topography and emissions (e.g., sites impacted by weekend recreational activities nearby, sites near stationary sources operating on weekly schedules).

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Figure 1

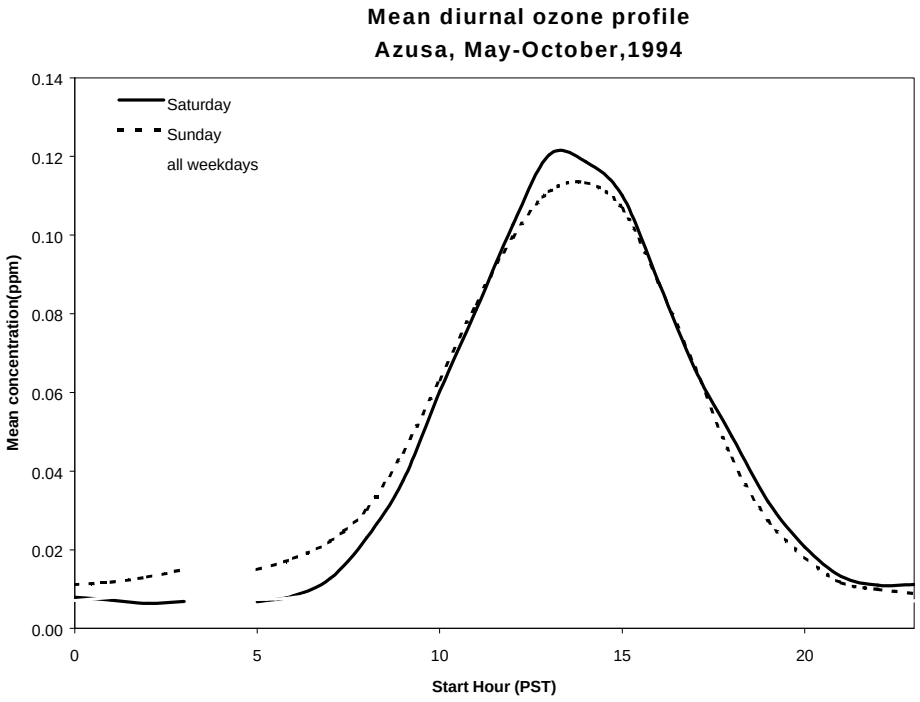

Figure 2

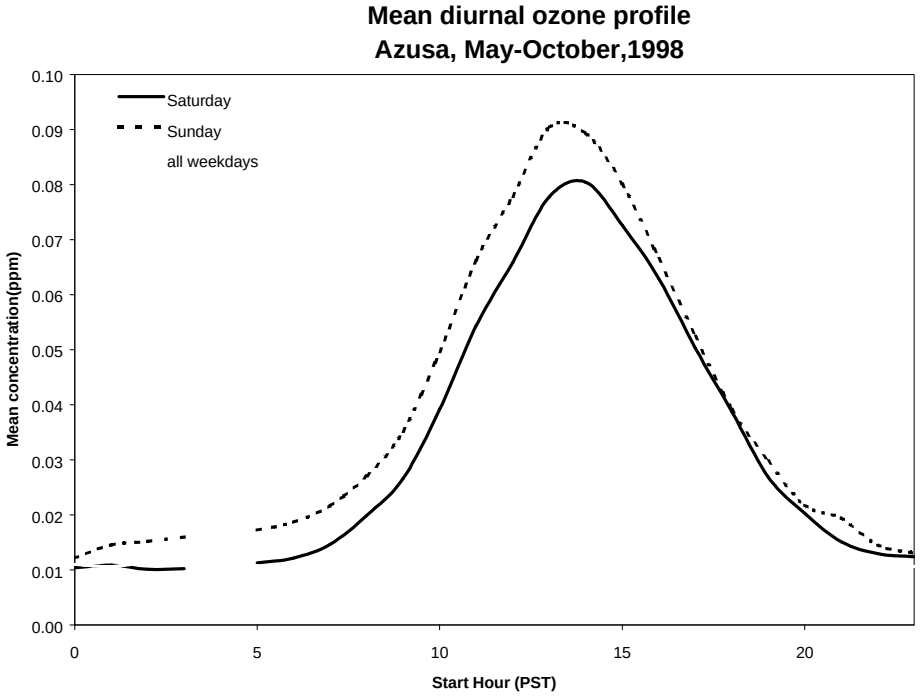

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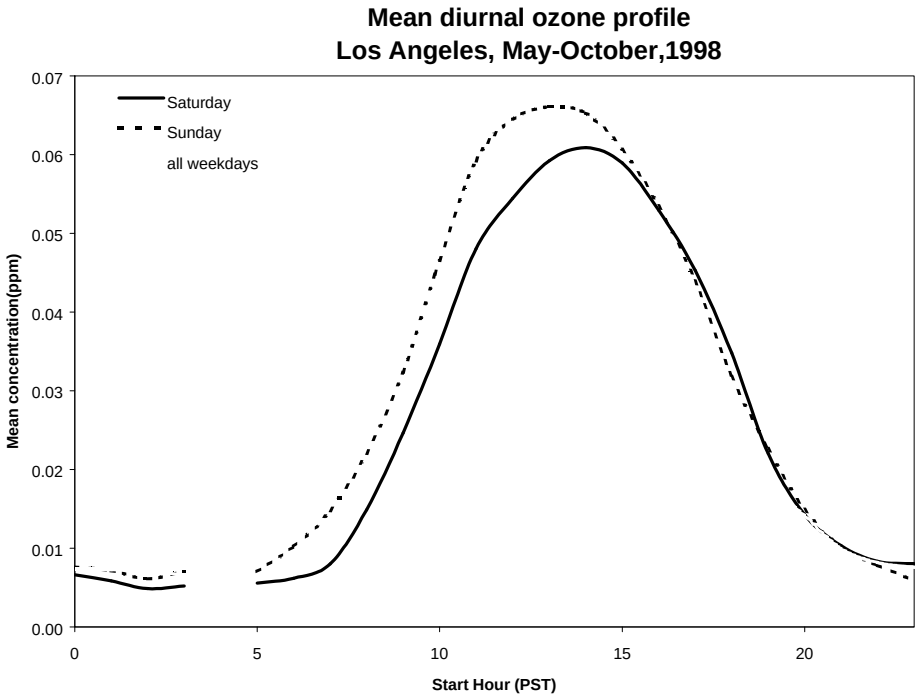
Figure 3



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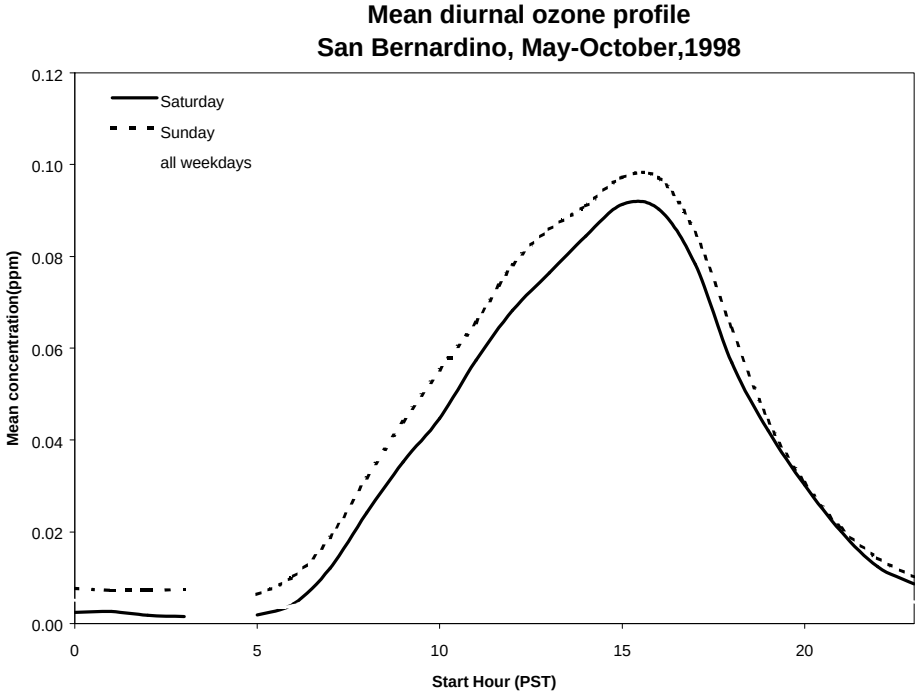

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Figure 5

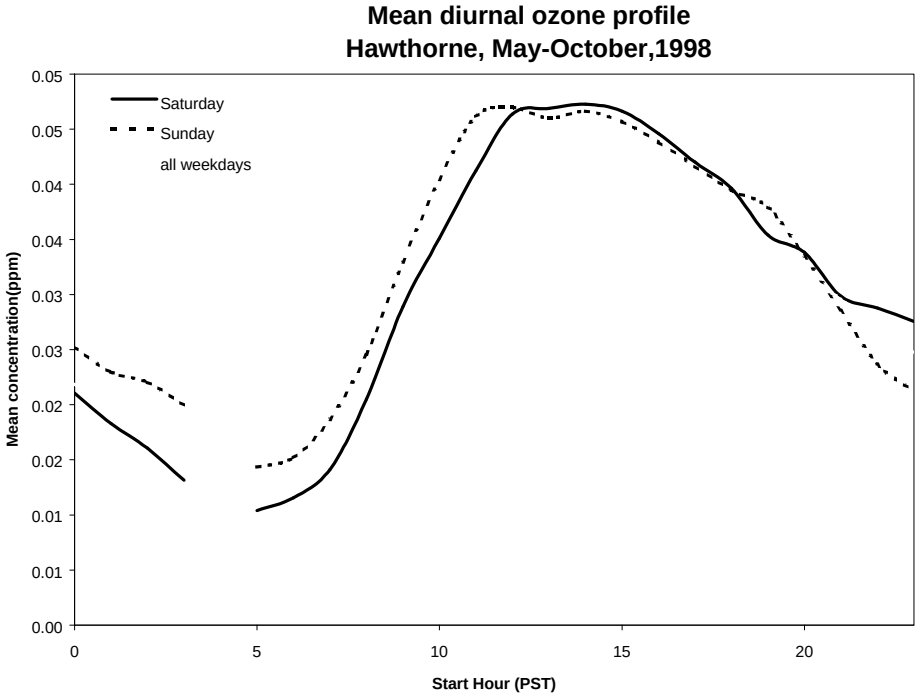

Figure 6

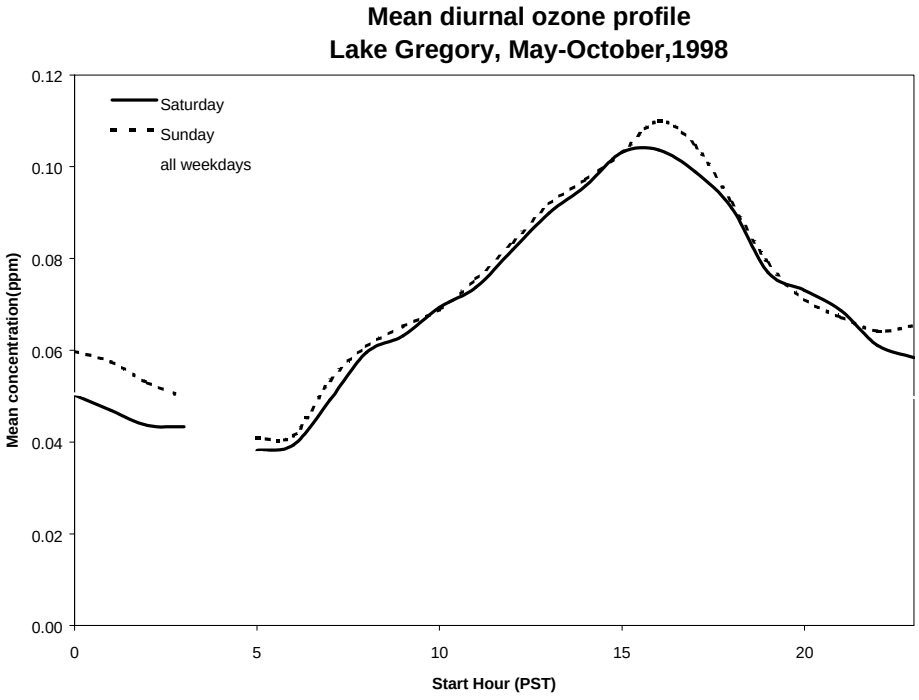

Figure 7

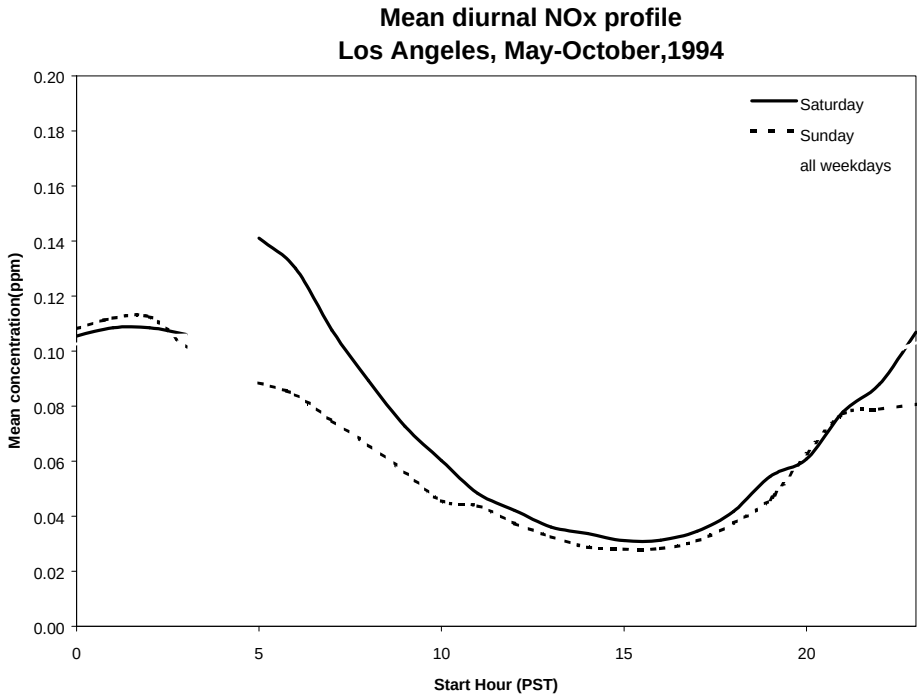

Figure 8

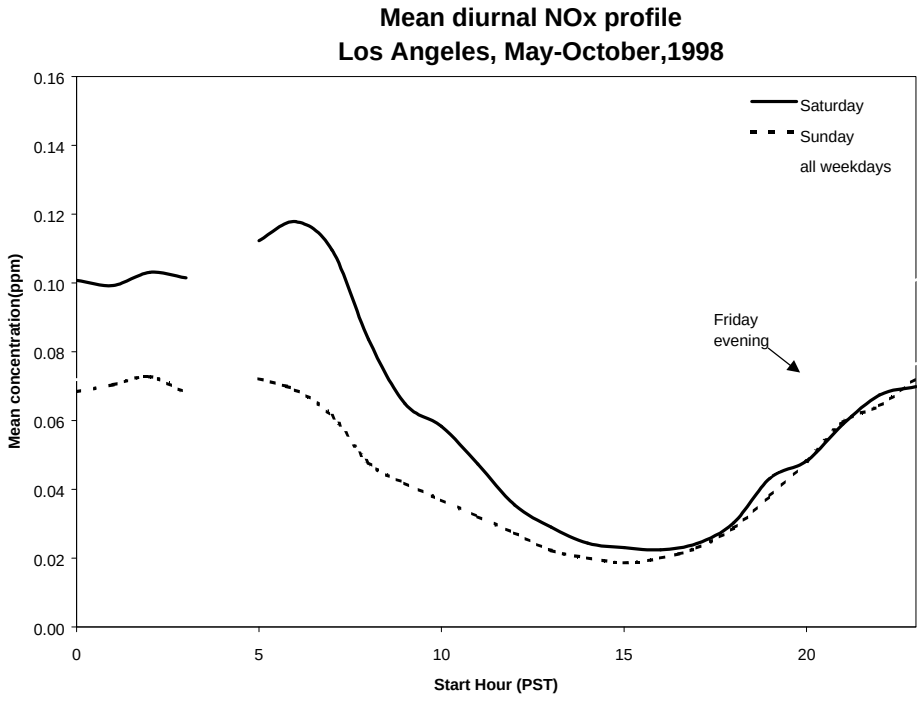

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Figure 9

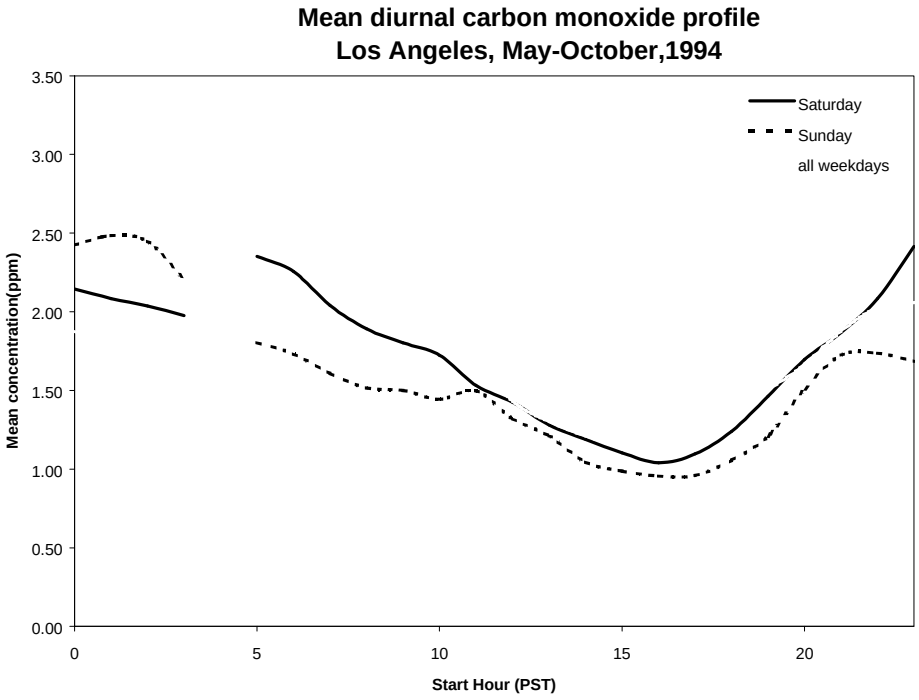

Figure 10

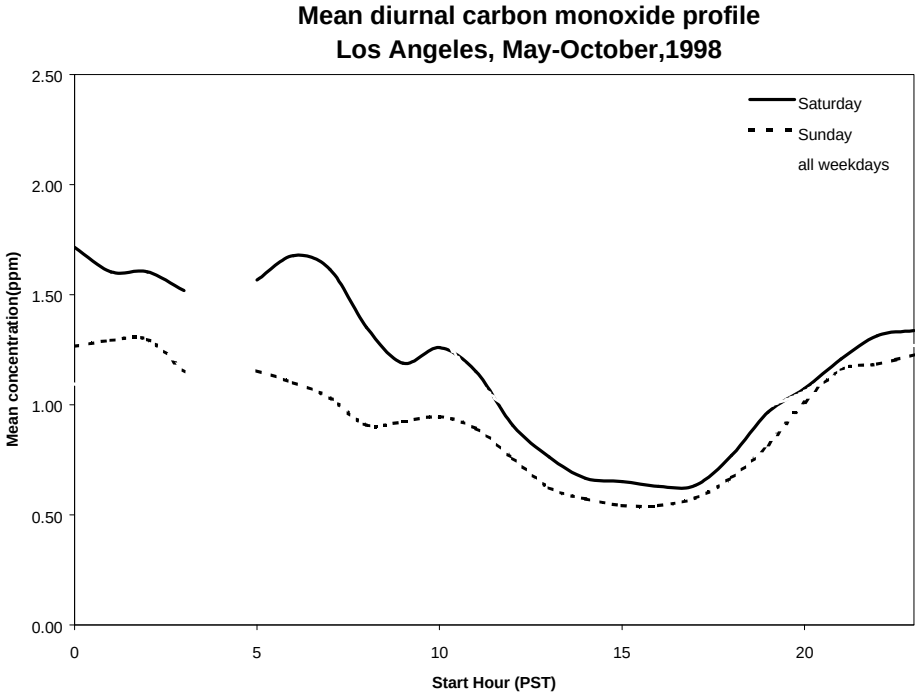

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Figure 11